



National Polar-orbiting Operational Satellite System (NPOESS) Microwave Imager/Sounder (MIS) Capabilities

**Pacific METSAT Working Group
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NPOESS

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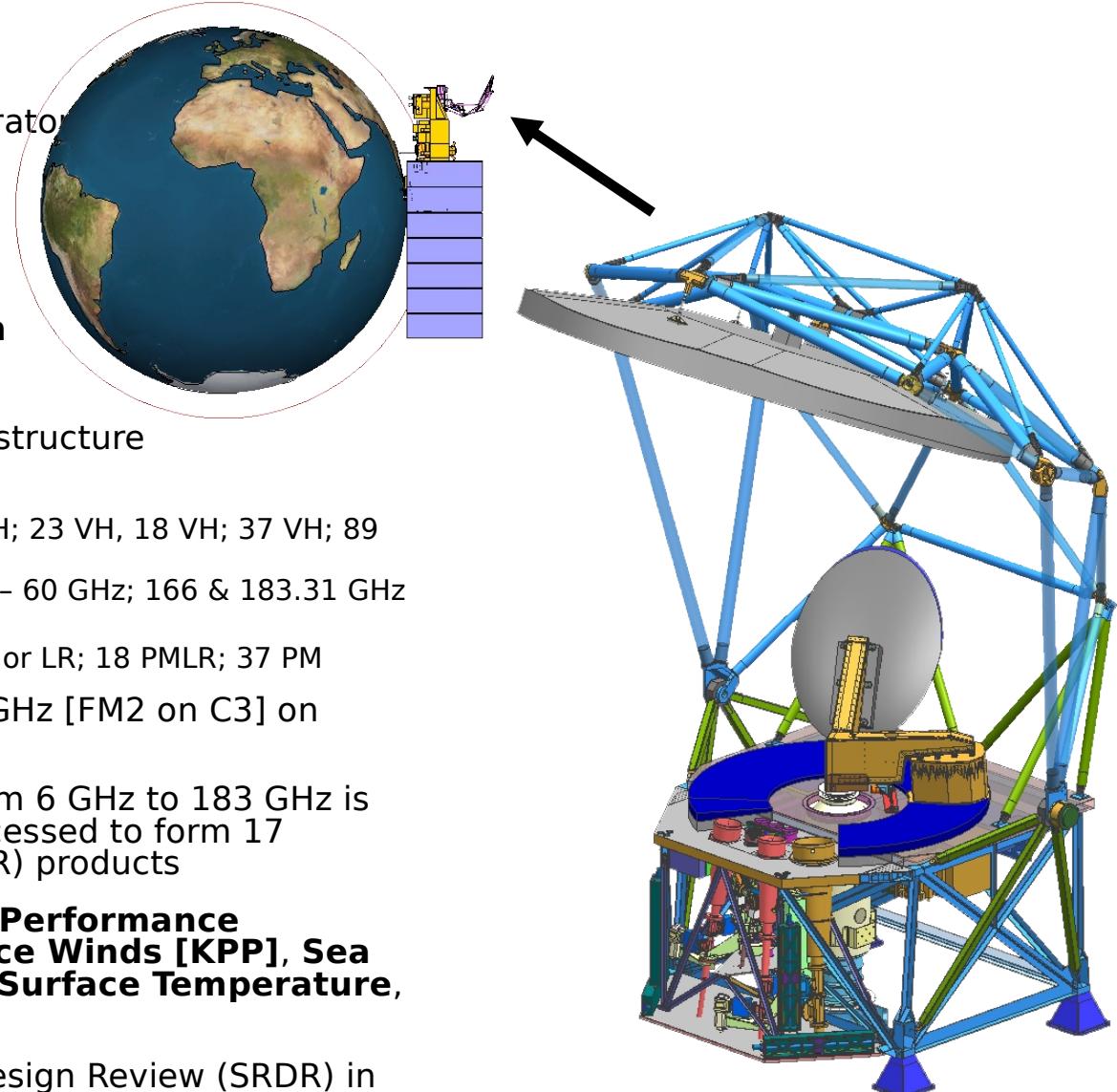
Agenda

- What is MIS?
- EDR Products
- Trade Space and Baseline
- MIS vs. Legacy
- Typhoon Warning-related EDRs
 - Sea Surface Winds
 - Sea Surface Temperature
 - Cloud Liquid Water, Precipitable Water
 - Precipitation Rate
 - Imagery
- Summary



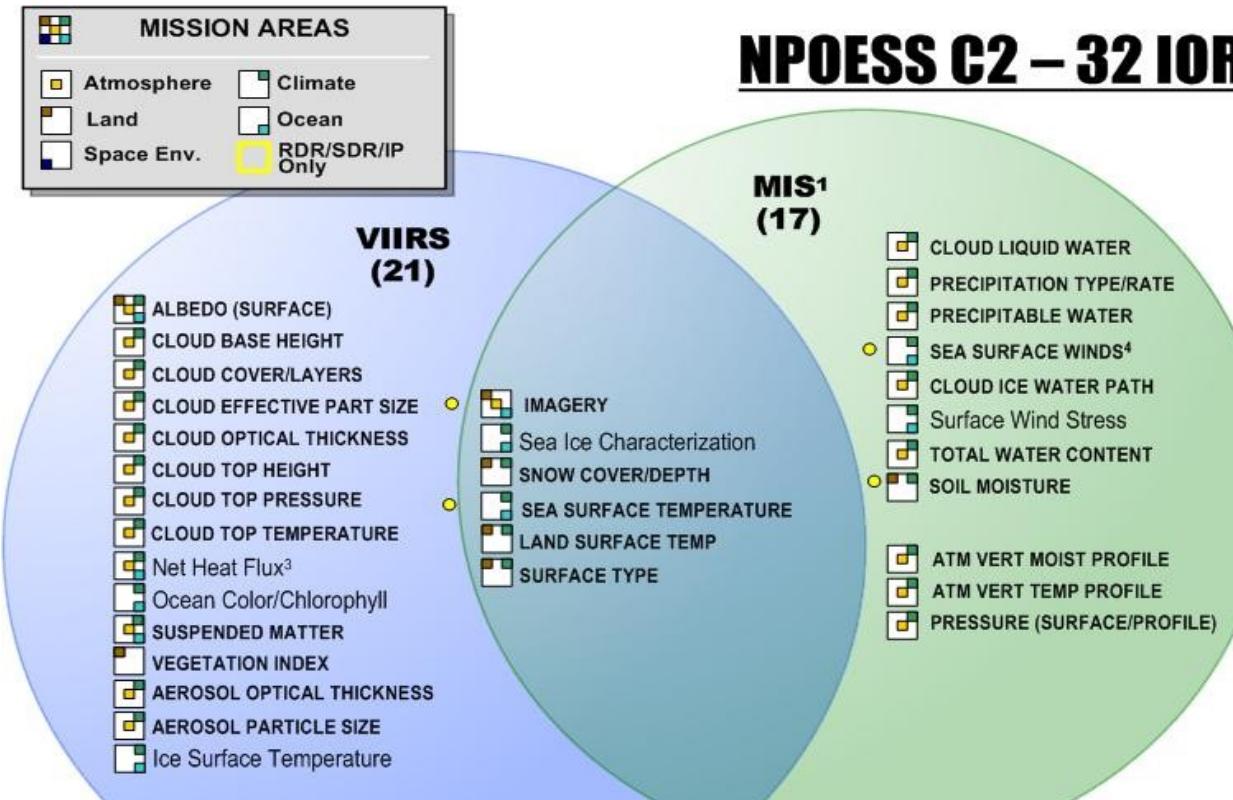
What is MIS?

- MIS is a GFE sensor, developed by the Naval Research Laboratory
- MIS FM1 on NPOESS C2
 - Launch date May 2016
 - (Current Best Estimate)
 - 17:30 orbit, 828 km
- **Conical scanning at 31.6 rpm**
- **Swath Width: ~1,700km**
- 1.8m main reflector deployable structure
- 39 Channels; 12 feedhorns
 - **Core Imaging Channels:** 10 VH; 23 VH, 18 VH; 37 VH; 89 VH
 - **Atmospheric Sounding:** 50.3 - 60 GHz; 166 & 183.31 GHz
 - Low Frequency: 6.8 VH
 - **Polarimetric Channels:** 10 PM or LR; 18 PMLR; 37 PM
- **Upper Air Sounding:** 60 - 63 GHz [FM2 on C3] on going trade study
- Upwelling Microwave energy from 6 GHz to 183 GHz is detected by the sensor and processed to form 17 Environmental Data Record (EDR) products
- Key EDRS: **Soil Moisture [Key Performance Parameter (KPP)], Sea Surface Winds [KPP], Sea Surface Wind Direction, Sea Surface Temperature, Imagery**
- Sensor System Requirements Design Review (SRDR) in May 2009





MIS EDRs (NPOESS C2)

**KEY**

- = EDRs with Key Performance Parameters
- BOLD CAPS** = LRD Environmental Data Records

EDRs not delivered by NPOESS are not counted in totals
Each sensor produces a unique product in overlap regions

NOTES:

1. EDR performance compliant with MIS TRD
2. N/A
3. Degraded by surface emissivity knowledge
4. Delivered as two MIS products – Speed (Key EDR) and Direction

03 March 2009

DoD, NOAA, NASA,
Integrated Program Office
M. Haas, F. Eastman
G. Mineart, J. Whitcomb

C2
V17



MIS Trade Space

	Existing Systems					MIS Concepts								Reference
	SSMIS	AMSR-E	TMI	WindSat		A	A-1	A-2	B	B-1	B-2	B-8	CMIS	
EDR (IORD II Thresholds)	APU HCS	APU HCS	APU HCS	APU HCS		APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS
Atm Vertical Moisture Profile		No Sounding	No Sounding	No Sounding		No Sounding	No Sounding		No Sounding	No Sounding				
LA Atm Vertical Temperature Profile	APU HCS	No Sounding	No Sounding	No Sounding		No Sounding	No Sounding		No Sounding	No Sounding				
UA Atm Vertical Temperature Profile		No Sounding	No Sounding	No Sounding		No Sounding	No Sounding		No Sounding	No Sounding	No UAS			APU HCS
Imagery														
Sea Surface Temperature	No 6/10 GHz	APU HCS	APU HCS	APU HCS		APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS
Sea Surface Wind Speed	APU HCS	HCS	APU HCS	APU HCS		APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS
Sea Surface Wind Direction (< 7m/s WS)		No Polarimetric Channels				No P Channels			No P Channels					
Sea Surface Wind Direction (>= 7m/s WS)		No Polarimetric Channels				APU HCS	APU HCS	APU HCS	No P Channels	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS
Soil Moisture	APU HCS		APU HCS											
Precipitable Water														
Precipitation Type/Rate*	APU* HCS	APU* HCS	APU* HCS	APU* HCS		APU* HCS	APU* HCS	APU* HCS	APU* HCS	APU* HCS	APU* HCS	APU* HCS	APU* HCS	APU* HCS
Pressure (Surface/Profile)		No Sounding	No Sounding	No Sounding		No Sounding	No Sounding	APU HCS	No Sounding	No Sounding	No Sounding			
Total Water Content		No Sounding	No Sounding	No Sounding		No Sounding	No Sounding	APU HCS	No Sounding	No Sounding	APU HCS	APU HCS	APU HCS	APU HCS
Cloud Base Height**	**	No Sounding	No Sounding	No Sounding		No Sounding	No Sounding	**	No Sounding	No Sounding	**	**	**	**
Cloud Ice Water Path		No Sounding	No Sounding	No Sounding		No Sounding	No Sounding		No Sounding	No Sounding	APU HCS	APU HCS	APU HCS	APU HCS
Cloud Liquid Water (Ocean)														
Snow Cover/Depth	APU HCS	APU HCS	No Data	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS
Ice Surface Temperature			No Data											
Sea Ice Characterization			No Data											
Surface Wind Stress					APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS
Legacy EDR Swath Width @ 828 km Altitude	1700	1450	1400	1200	~1700	~1700	~1700	~1700	~1700	~1700	~1700	~1700	~1700	1700

* Precipitation is highly variable and cannot be validated (Dr R. Spencer @ MOAT)

** Algorithm has not been developed

W/R/T IORD-II

No Capability
Useful Data/Marginal
Min IORD Capability
IORD or Better
Unknown

A: 1.2 meter Antenna

B: 1.8 meter Ant. + 6 GHz

x1: Core Imaging + Polarimetry
x2: Core + Polarimetry + Soundin
B8: 1 + 2 + Upper Air Sounding



MIS System Spec Baseline

	Existing Systems				MIS Concepts								Reference
	SSMIS	AMSR-E	TMI	WindSat	A	A-1	A-2	B	B-1	B-2	B-8	CMIS	
EDR (IORD II Thresholds)	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	APU HCS	
Atm Vertical Moisture Profile		No Sounding	No Sounding	No Sounding	No Sounding	No Sounding	No Sounding	No Sounding	No Sounding	No Sounding	No Sounding	No Sounding	
LA Atm Vertical Temperature Profile	APU HCS	No Sounding	No Sounding	No Sounding	No Sounding	No Sounding	No Sounding	No Sounding	No Sounding	No Sounding	No Sounding	No Sounding	
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Imagery													
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* Precipitation is highly variable and cannot be validated (Dr R. Spencer @ MOAT)													
** Algorithm has not been developed													

A, A-1, A-2 Provides Inadequate Spatial Resolution for IORD-II

B-2 Equals or Surpasses Legacy Performance (no UAS)

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IORD or Better
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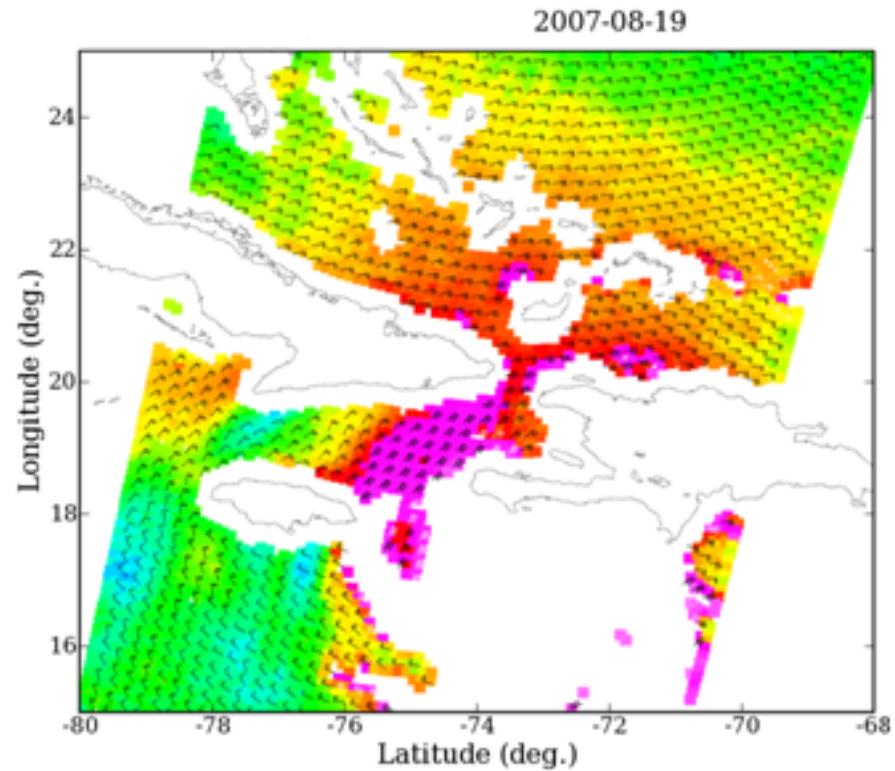
MIS vs. Legacy

EDRs	Cell Size	Measurement Range	APU	Conditions	Improvements
Integrated Water	58 → 25 km	0–80 mm	10% or 2mm (U)		Resolution
Wind Speed	58 → 30 km	0–25 m/s	1.4 m/s (P)	No rain unbinned	Resolution
Wind Direction	~45 km	>6 m/s	<30° (P)		New (WindSat)
SST (All Weather)	60 km	271–307 K	<1 K (U)		New (AMSR-E)
Soil Moisture	60 km	0–50%+	10% (U)	<1/5 kg/m ² Cover	New (AMSR-E)
Snow (WE)	58 → 25 km	0–25 cm	3 cm (P)		Resolution
Sea Ice (Age) (Concentration)	58 → 25 km	Multi-Year/New 0–100%	20% (U) 10% (U)		Resolution



Sea Surface Winds

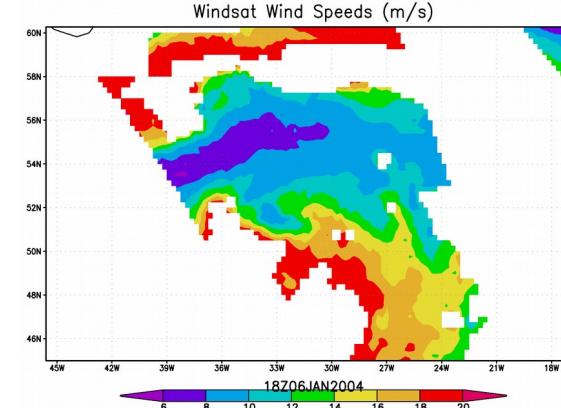
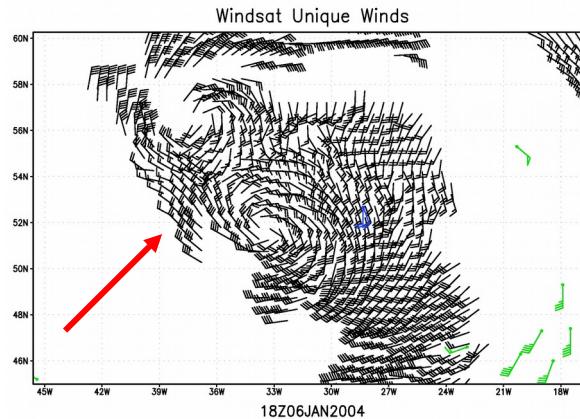
- MIS expected to produce sea surface wind vectors similar to on-orbit capability of WindSat
- Wind direction capability has shown significant utility for improving typhoon forecasts
- UK Met office is now assimilating WindSat data into their Global Model
 - Demonstrated positive impact on Forecasting Tropical Cyclone tracks



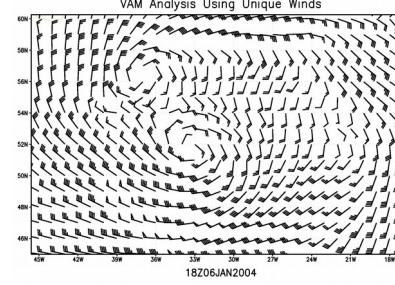
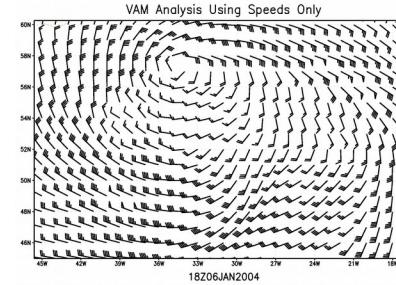
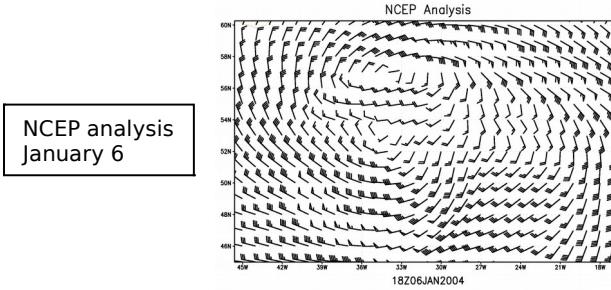
Wind direction retrievals using WindSat data in the Caribbean, 19 Aug 07



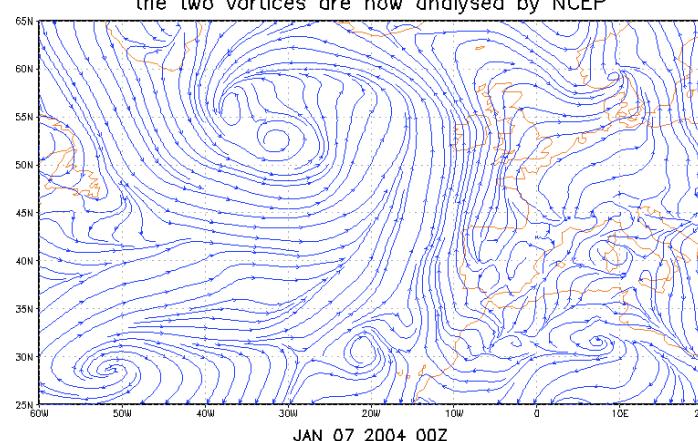
WindSat Data Comparison



**WindSat Data Comparison
with NCEP Forecast Model
Showing Detection**
(Analysis by R. Atlas, NOAA
AMOL, Ocean Sciences
Conference, February 2006).



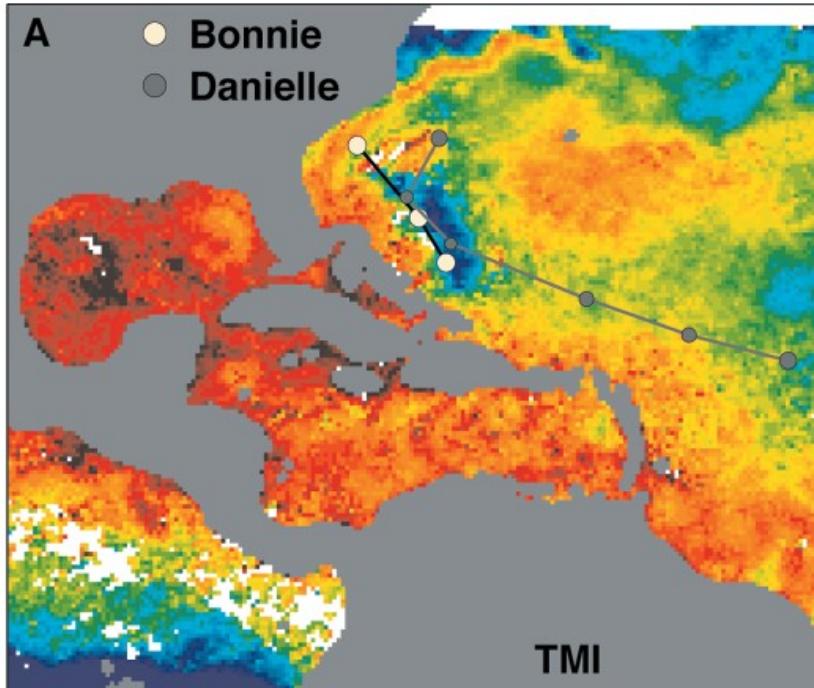
**WindSat Surface Wind retrievals
in the North Atlantic show the
presence
of paired cyclonic vortices not
captured
until the following day by the
National
Center for Environmental**



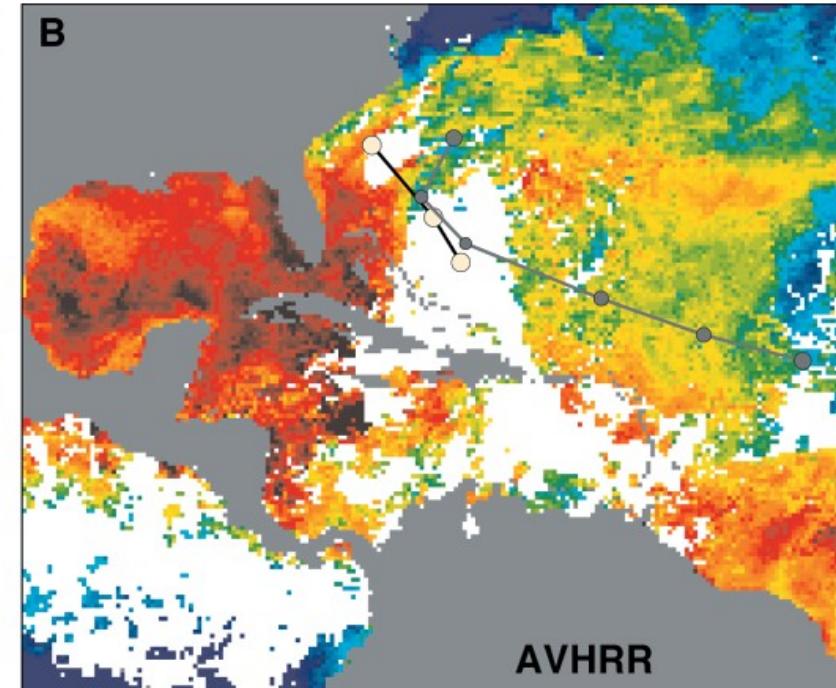
NCEP analysis
January 7



Sea Surface Temperature



[LEFT] A cold wake (blue region near the white circles) was produced by Hurricane Bonnie on 24 to 26 August 1998, as seen by the TRMM Microwave Imager (TMI)



[RIGHT] The cold wake was not seen by the visible/infrared AVHRR imager (right) due to areas of persistent rain and cloud cover (white patches) over the 3-day period.

White dots: Hurricane Bonnie's daily position as it moved northwest from 24 through 26 August.

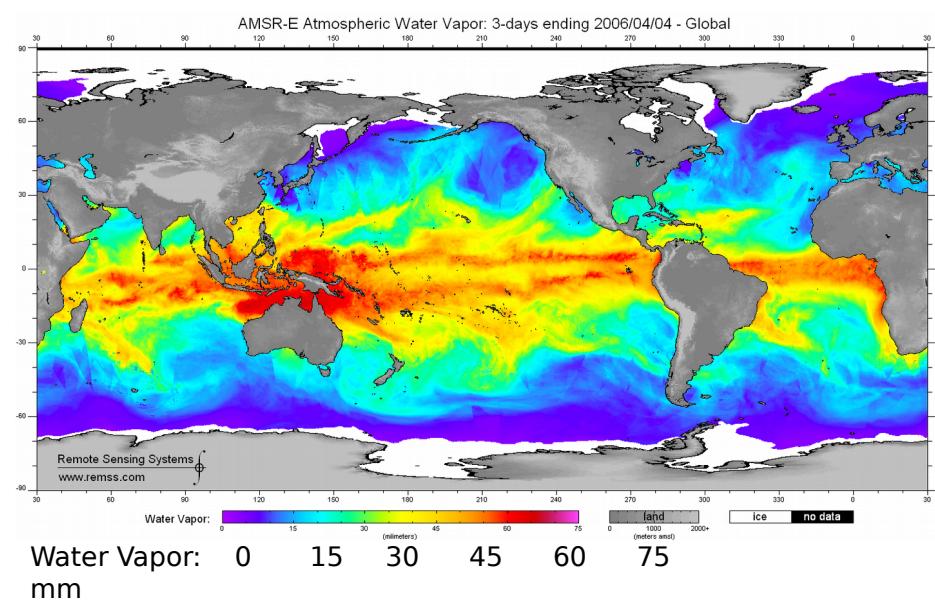
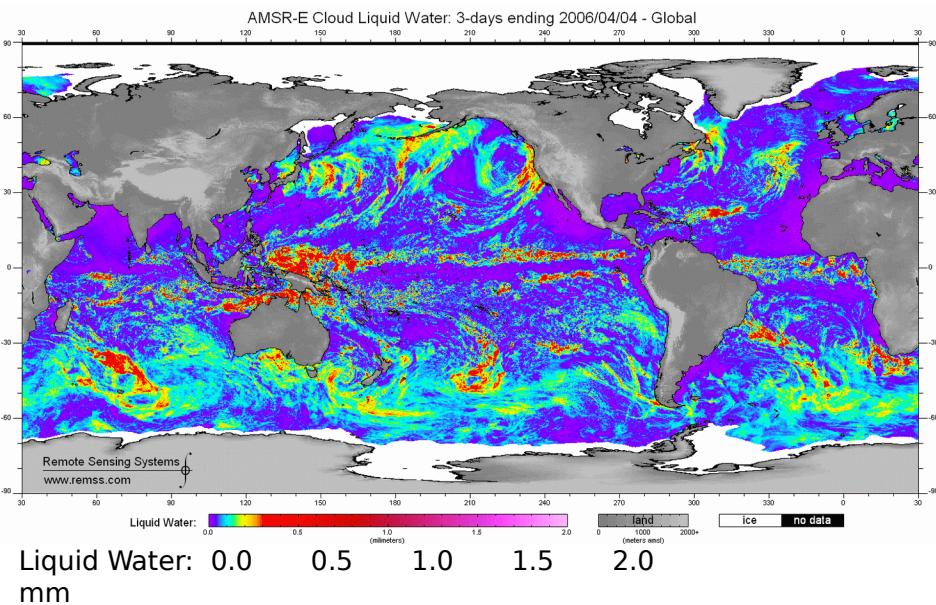
Gray dots: Hurricane Danielle as it moved northwest from 27 August through 1 September.

Danielle crossed Bonnie's cold wake on 29 August and its intensity dropped. Cloud cover prevented AVHRR from observing this sequence, however, TMI was able to



Cloud Liquid Water and Precipitable Water

MSR-E Cloud Liquid Water: 3-days ending 20060404 Atmospheric Water Vapor: 3-days ending 20060404



Global maps of total Precipitable Water and Cloud Liquid Water are produced from AMSR-E data on the Aqua satellite and from SSM/I and SSMIS on DMSP.

These datasets have value for weather forecasts and models of the energy and water cycles.

Precipitable Water Vapor is considered critical for data continuity for GEOSS.

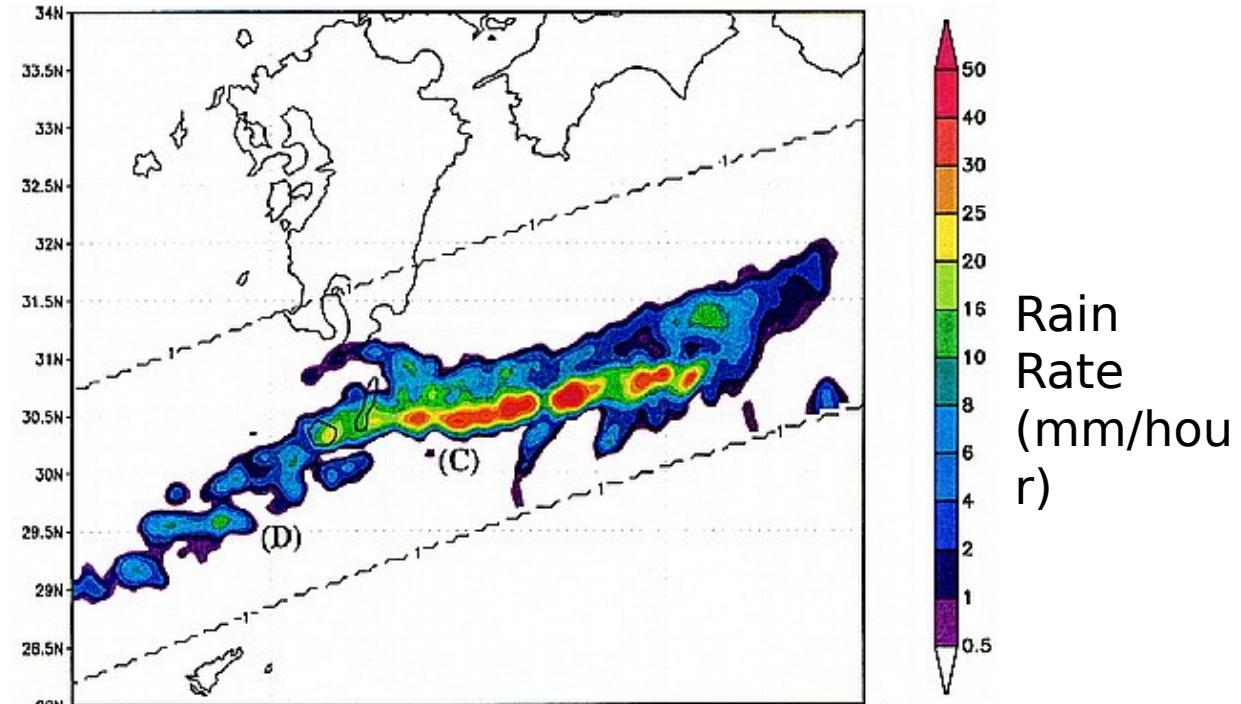
Only microwave sensors can provide estimates of Cloud Liquid Water.

MIS provides same performance as AMSR-E.



Precipitation Rate

**Rain rate (mm/h)
at 2 km height
from TMI. Squall
line south of Japan.
(From Aonashi and
Liu, JAM, 2000).**

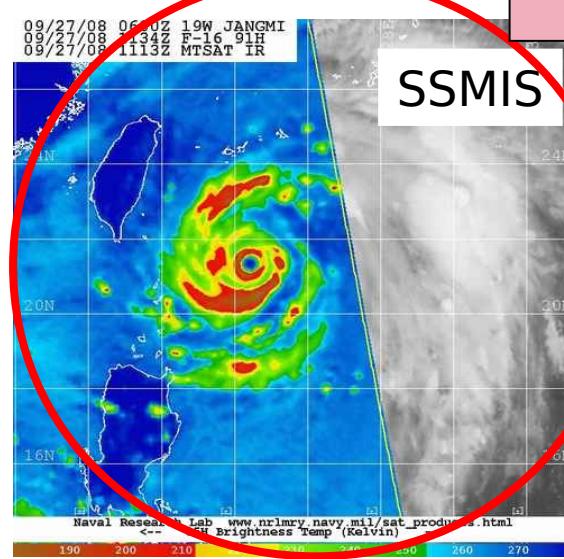
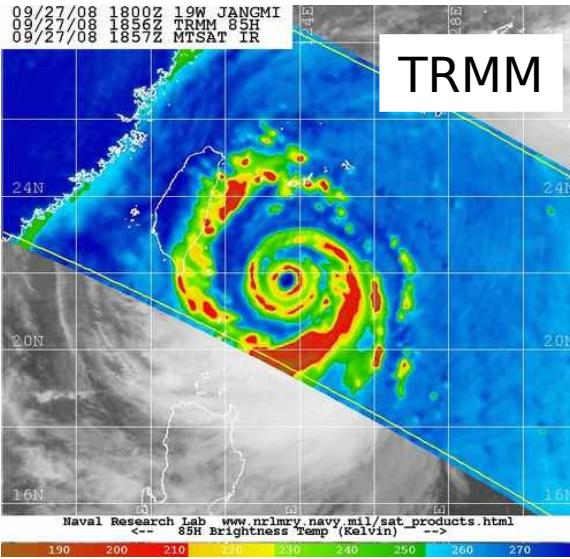
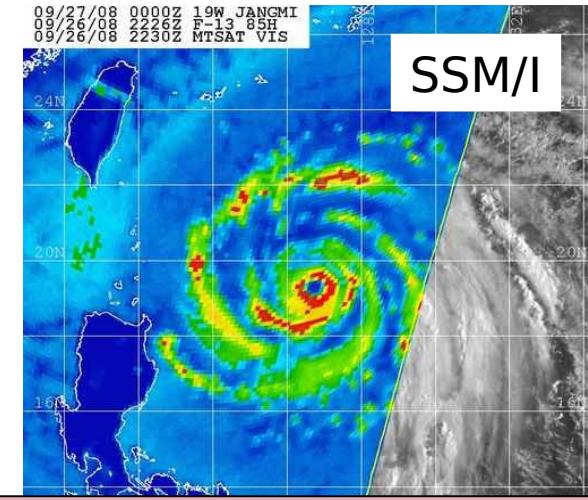
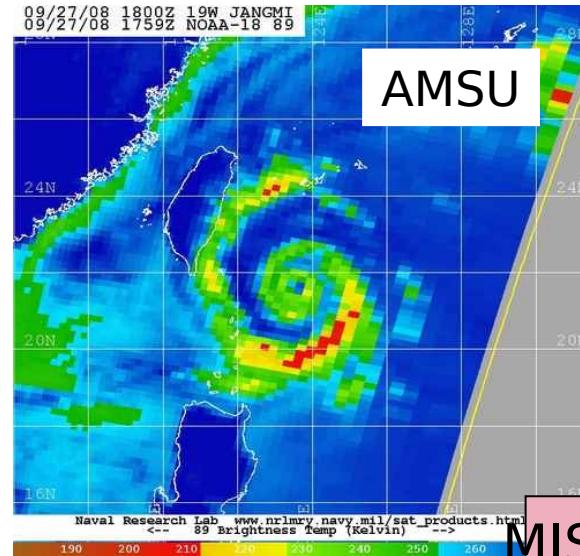
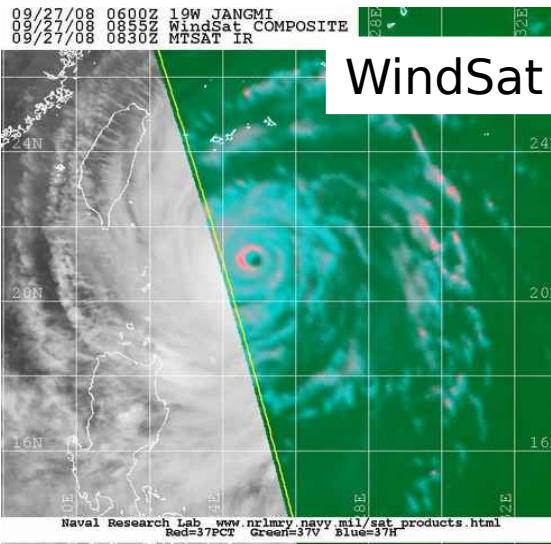


**Measurements of precipitation rate are valuable for tactical maneuvers,
maritime navigation, and fisheries dynamics, and supports climate studies.**

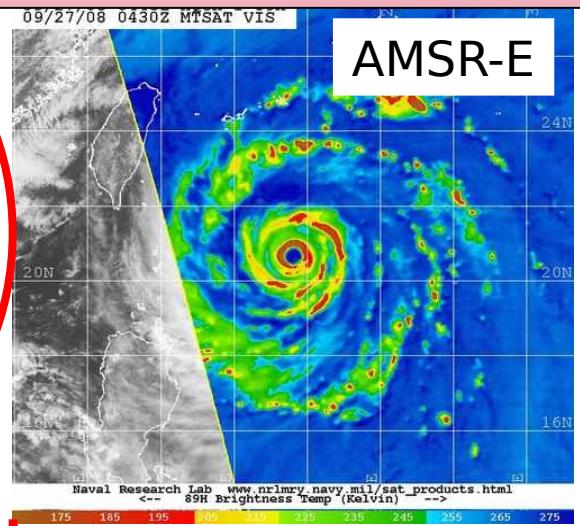
MIS will provide global rain rate measurements.



Imagery



MIS Imagery HCS will closely resemble SSMIS





Summary

- NPOESS MIS development continues to represent the latest most capable operational microwave radiometer
 - MIS is responsible for 17 EDRs (includes 2 NPOESS KPPs)
 - MIS offers improvements to nearly all legacy EDRs:
 - DMSP SSMIS: Better horizontal spatial resolution
 - NASA AMSR-E: RFI mitigation for 6 GHz
 - NRL WindSat: Similar wind direction capability
 - Improvements to weather forecasts are expected from MIS atmospheric sounding, wind direction, and all weather sea surface temperature capabilities